NEW RECORDS OF OPHIUROIDEA (ECHINODERMATA) FROM SOUTHERN AUSTRALIA, INCLUDING NEW SPECIES OF *OPHIACANTHA* AND *OPHIONEREIS*

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Summary

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Twenty-three ophiuroid species are discussed: nine are new to the region, and the known range of a further seven is extended. *Ophionereis terba* n. sp. and *Ophiacantha shepherdi* n. sp., are described from Victorian and South Australian waters respectively, and a key to the southern Australian species of *Ophiacantha* is provided. *Ophioceres bispinosus*, *Ophioconis opacum*, and *Ophioprium rosea* are new combinations, and the following species are synonymised: *Ophiacantha abyssicola otagoensis* Fell with *O. brachygnatha* H. L. Clark, *Ophiacantha truncata* Koehler with *Ophioprium rosea* (Lyman), and *Ophiactis laevis* H. L. Clark with *O. tricolor* H. L. Clark. Illustrations are given of holotypes of *Ophioceres bispinosus*, *Ophiomusium anisacanthum*, *O. australe*, *Ophionereis lineata*, *Amphiura trisacantha*, *Ophriothrix* (*Placophiothrix*) *albostriata*, *O.* (*Placophiothrix*) *lineocaerulea*, and *O.* (*Keystonea*) *hymenacantha*. A lectotype is designated for *Ophiocantha clavigera* Koehler.

Introduction

The ophiuroid fauna of southern Australian waters is known largely from the studies of H. L. Clark (1916, 1918, 1928, 1938, 1946) and A. M. Clark (1966). H. L. Clark's early paper covered collections trawled from the continental shelf by F.I.S. "Endeavour" in 1910–14, and the later works dealt with specimens collected mainly from the Victorian coast by Joseph Gabriel, and from South Australian waters by Sir Joseph Verco and Clark himself during a visit in 1929. In 1946, Clark added more specimens in his revision of the entire Australian echinoderm fauna. The recent account by A. M. Clark was based on shallow water collections made during the Port Phillip Survey, Victoria, 1957–63. The collections reported by these authors are in the South Australian Museum, National Museum of Victoria, Australian Museum, Museum of Comparative Zoology, and British Museum (Natural History). Seventy-four species of ophiuroids are now known from southern Australia between Cape Howe, Victoria (37°30.1'S) and Cape Naturaliste, Western Australia (33°30.1'S) (Clark 1946, Baker 1981, and this paper).

In the course of studying Australasian Ophiuroidea in the past few years we have examined recent collections made by trawling expeditions (H.M.A.S. Diamantina and Kimbla, M.V. Aquarius, and M.V. Sarda) and divers working along the coasts of Western Australia, South Australia, Victoria, and Tasmania. Among these collections are a number of species previously unknown in the region, including two new species and others hitherto known only from other Pacific localities, particularly New Zealand. Some of these have been discussed by Baker (1979, 1980), and the remainder are reported here.

During visits to the South Australian Museum, one of us (A.N.B.) re-examined some of the ophiuroid material recorded by H. L. Clark (1928), and re-illustrated, by camera lucida drawings, several holotypes of local species described but not figured in detail by that worker. Our studies have shown that some taxonomic changes are necessary, and we have included such information in this paper.

Text conventions

The following abbreviations are used: *Institutions:* AM—Australian Museum, Sydney. BM(NH)—British Museum (Natural History), London. BPBM—Bernice P. Bishop Museum, Honolulu, Hawaii. MCZ—Museum of Comparative Zoology, Harvard. MNB—Museum für Naturkunde, Berlin. NMNZ—National Museum of New Zealand, Wellington. NMV—National Museum of Victoria, Melbourne.

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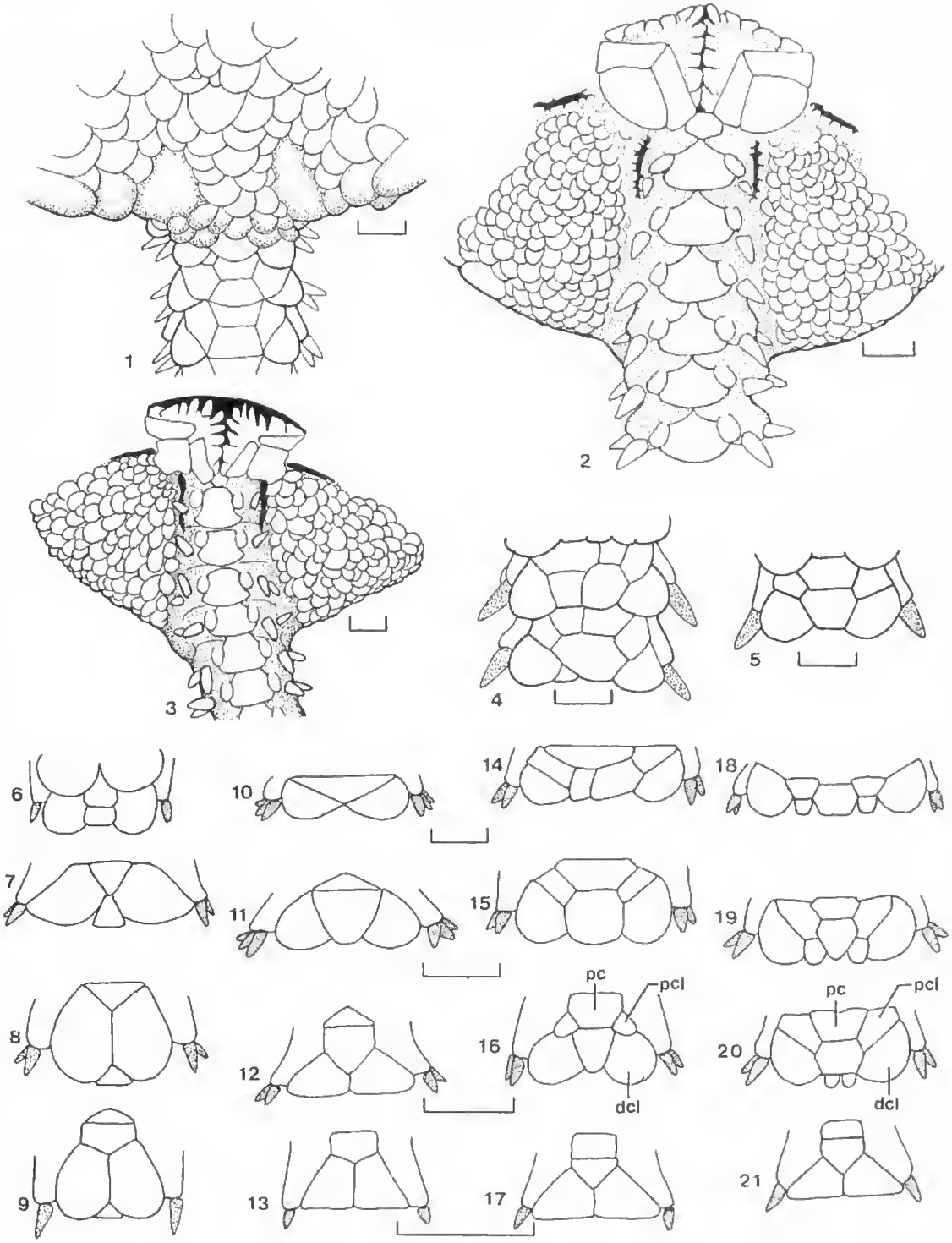
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SAM—South Australian Museum, Adelaide. WAM—Western Australian Museum, Perth. ZMH—Zoologisches Museum, Hamburg. ZMC—Zoologisk Museum, Copenhagen. *Morphology:* d.d.—disc diameter.

Systematic Account

FAMILY Ophiuridae

Subfamily Ophiolepidinae

Ophioceres Koehler, 1922

Ophioceres bispinosus (H. L. Clark) n. comb.

FIGS 1–3, 5, 14–17

Ophioplocus bispinosus H. L. Clark, 1918: 337, pl. 4, fig. 2; 1946: 276.– A. M. Clark, 1966: 327.– Dartnall, 1980: 43.

Specimens examined: Holotype, MCZ 4025, Phillip Is. Westernport, Vic., no depth, May, 1915; 2, NMNZ 2074, Port Macdonnell, S.A., 3–4 m 29.iii.1964; 1, NMNZ 2076, West Id, S.A., 4 m, 29.i.1975; 2, NMV, H366, Cape Liptrap, Vic., no depth, 24.ii.1979; 2, NMNZ 2075, Fluted Cape, Bruny Id, Tas., 13 m, 10.ii.1972; 1, NMNZ 2702, Deal Id, Tas., 20 m, 4.v.1974.

Remarks: These specimens range 3–9.5 mm d.d., and have arms up to 3.3 × d.d. long. They are thus similar to the type series in dimensions.

That this species belongs in *Ophioceres* rather than *Ophioplocus* is shown by the presence of one tentacle scale to each pore, short genital slits originating close to the oral shield and hardly extending past the first ventral arm plate, and the relatively small amount of fragmentation of the dorsal arm plates (<10 pieces). In *Ophioplocus* Lyman, there are 3–6 tentacle scales, genital slits which are separated from the oral shields by small platelets or scales and which extend as far as the fourth segment, and extensive dorsal arm plate fragmentation (<20 pieces).

As pointed out by H. L. Clark (1918), this species is extremely close to *O. huttoni* (Farquhar) from New Zealand. Examination of 15 specimens of the latter (NMNZ) shows small but consistent differences which we consider to be specific. Clark's suggestion that the number and arrangement of dorsal arm plate fragments is different in these two species is correct, but only for the basal and middle part of the arms. To confuse matters, however, the basic pattern of fragmentation may be altered by irregular secondary division of plates on some or all arms of some specimens. The dorsal arm plates consist of three main elements—a central plate bordered by two lateral plates. The central plate is usually divided transversely, and on the extremities of the arms, the arrangement is virtually identical in both species (Figs 17 & 21). Nearer the disc, the lateral plates become separated from the proximal portion of the central plate by an oblique plate on each side (Figs 16 & 20). At this stage of fragmentation, a difference between the two species is evident—in *huttoni* the pair of additional oblique proximal centro-lateral plates (pcl) nearly as wide as the distal centro-laterals (dcl) and fully in contact with the lateral edge of the proximal central plate (pc), becomes wedged between the proximal centro-laterals and the distal central plate; in *bispinosus* however, the additional pcl plates are usually less than ½ the width of the dcl plates and only in contact with the posterior lateral portion of the pc plate. On the same arm segment, and even more pronounced on proximal segments (Figs 15 & 19), the latter species does not develop a third pair of plates distad or disto-lateral to the dcp as seen in *huttoni* (Figs 16 & 20, 15 & 19). Occasionally, irregular longitudinal splits occur on the very basal arm plates of *O. bispinosus* (Figs 4 & 14).

The oral shields also differ in proportions—in *bispinosus* they are noticeably wider than long (w = 1.44–1.63L), whereas in *huttoni* they are about as wide as long (w = 1.05–1.13L).

Although there is no noticeable difference in the arrangement of the disc scales, the radial shields and marginal inter-radial plates are larger in *bispinosus* than in *huttoni*. In fact the size of the plates rival those in *O. marginata* Fell, a second New Zealand species, regarded

Figs 1–21. 1, arm base and adjoining disc, dorsal, of *Ophioceres bispinosus* (NMNZ 2074); 2, same, ventral; 3, arm base and adjoining disc, ventral, of *Ophioceres incipiens* (NMNZ 2715); 4, 6th & 7th arm segments of *O. bispinosus* (NMV H366); 5, 6th arm segment of *O. bispinosus* (holotype MCZ 4025); 6–9, 2nd, 8th, 18th and distal arm segments of *O. incipiens* (NMNZ 2715); 10–13, same segments of *O. marginata* (NMNZ 2705); 14–17, same segments of *O. bispinosus* (NMNZ 2074); 18–21, same segments of *O. huttoni* (NMNZ 1183). Abbreviations: pc—proximal central plates; dcl—distal centro-lateral plates; pcl—proximal centro-lateral plates. Scale lines 0.5 mm.

here as valid (see Pawson 1969). This species can be distinguished from *bispinosus* and *huttoni* by its shorter arms (2 × d.d.), simpler pattern of arm plate fragmentation (Figs 10–13), shorter genital slits, and 3 instead of 2 arm spines on each segment. Unlike the other species, *O. marginata* is viviparous—a 9.0 mm d.d. specimen dissected during this study contained 18 juveniles 1–1.3 mm d.d.

The fourth species and type species, *O. incipiens* Koehler, also has a simple pattern of arm plate fragments (Figs 6–9), but has arrowhead-shaped oral shields (Fig. 3), 2 very short arm spines, and relatively long (3.3 × d.d.) arms.

The four *Ophioceres* species are restricted to the southern hemisphere antarctic, subantarctic, and cool temperate waters. *O. incipiens* is circumpolar in antarctic waters; *marginata* subantarctic New Zealand, and southern mainland New Zealand, *huttoni* northern New Zealand, and *bispinosus* southern Australia. *Ophioceres* species are recorded at depths of 0–384 m.

Ophiomusium Lyman, 1869

Ophiomusium anisacanthum H. L. Clark

FIGS 22–24

Ophiomusium anisacanthum H. L. Clark, 1928: 445, figs 133a, b; 1946: 247.– Baker, 1979: 31.
Specimens examined: Holotype, SAM K254, and 2 paratypes, K256, Spencer Gulf or Gulf St Vincent, S.A.; 4, WAM 896–898–77, 31°00′S, 114°51′E, W of Lancelin, W.A., 130–160 m, HMAS Diamantina stations 41, 44.

Remarks: The Western Australian specimens of *O. anisacanthum* range 11–12 mm d.d., with arms 40 mm long, and are thus comparable with H. L. Clark's type series of five—the only other examples hitherto reported. Clark (1928) characterized this species by its single, large ventral inter-radial plate and one large arm spine in a series of three or four smaller spines. In the six specimens examined here, we find mostly four spines on the basal seven or eight segments. They grade in size from the lowermost, which is 0.5–0.75 as long as the segment bearing it, to the uppermost, which is 0.2 as long as a segment. The two lowermost spines are distinctly separated from the uppermost pair (Fig. 24). Beyond the seventh or eighth segment, only the lowermost pair are present. It is this arrangement of arm spines, plus the large inter-radial plate and the smooth, closely adpressed dorsal disc plates, that distinguish the species.

The type specimens are without exact locality or depth, Verco's label bearing no more than "Spencer or St Vincent Gulfs". H. L. Clark (1946) expressed interest in the depths at which *anisacanthum* might eventually be found, for the genus is essentially a deep water one, and the South Australian gulfs are less than 55 m deep. It is thus of considerable interest that the species has now been collected off the Western Australian coast in 130–160 m, showing that *O. anisacanthum* is indeed one of the few species in this genus to inhabit the continental shelf.

Ophiomusium australe (H. L. Clark)

FIGS 25–27

Ophiomusium simplex var. *australe* H. L. Clark 1928: 449, fig. 135; 1946: 274–5.
Ophiomusium aporum H. L. Clark, 1928: 447, fig. 134; 1946: 275.
Ophiomusium australe.– Baker, 1979: 30.
Specimens examined: 9 from Vic., S.A. and W.A. (listed in Baker 1979, p. 30), 3, NMV H367 38°46′S, 141°33′E, 155 m, 26.viii.1975.

Remarks: This southern Australian species has been discussed by Baker (1979). The opportunity is taken here to give a detailed illustration of the holotype (SAM K256).

FAMILY Ophionereididae

Ophionereis Lütken, 1859

Ophionereis terba n.sp.

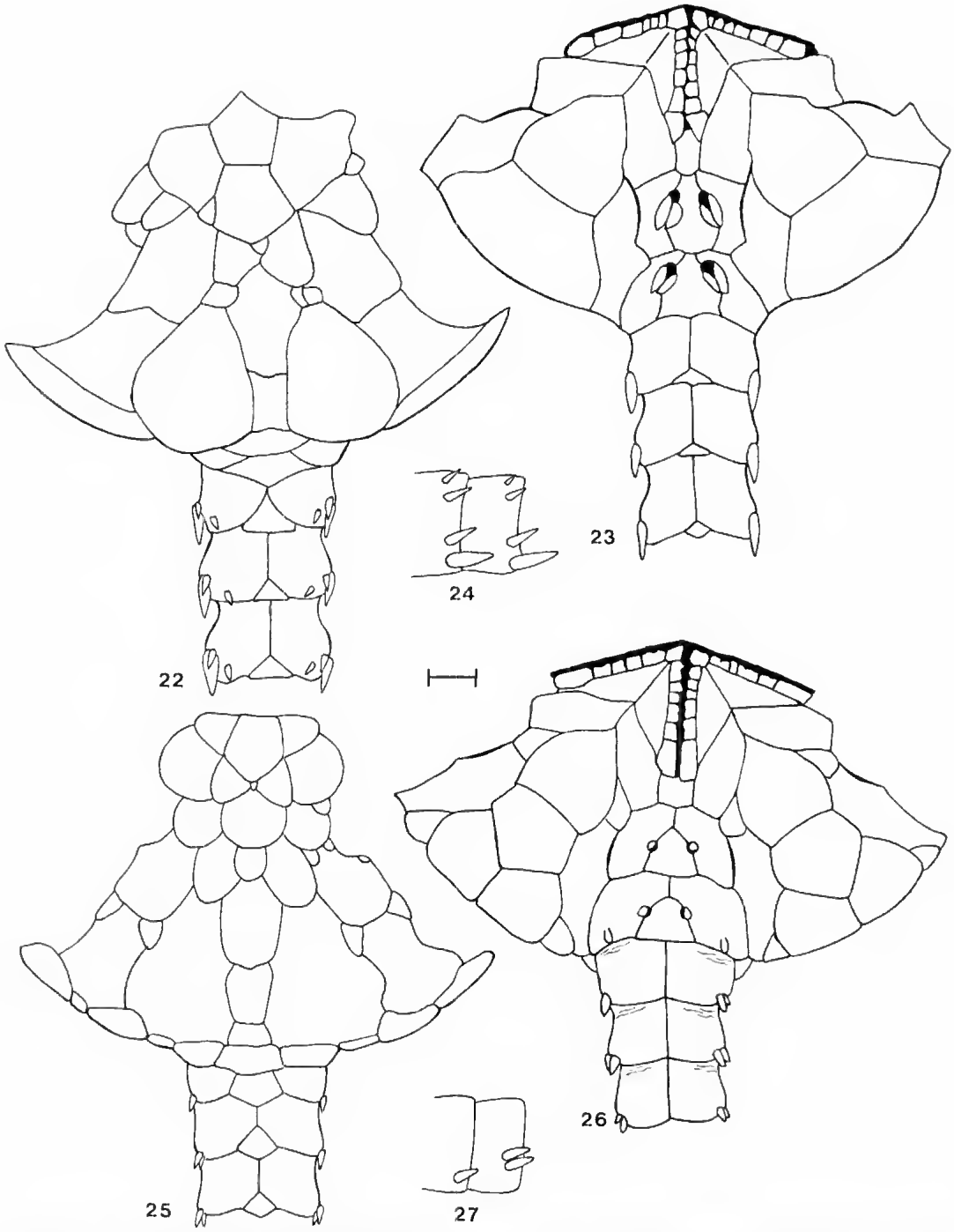
FIG. 30

Specimens examined: Holotype NMV H363 & paratype, NMNZ 3673, 43 km SSW Portland, Vic., 585 m, coll. R. Plant & M. Gomon, 14.v. 1979; paratypes 4, NMV, W of Cape Nelson, Vic., 164–201 m, June 1969; paratypes 2, NMNZ 1881, S of Warrnambool, Vic., 220–310 m, 14.V. 1969.

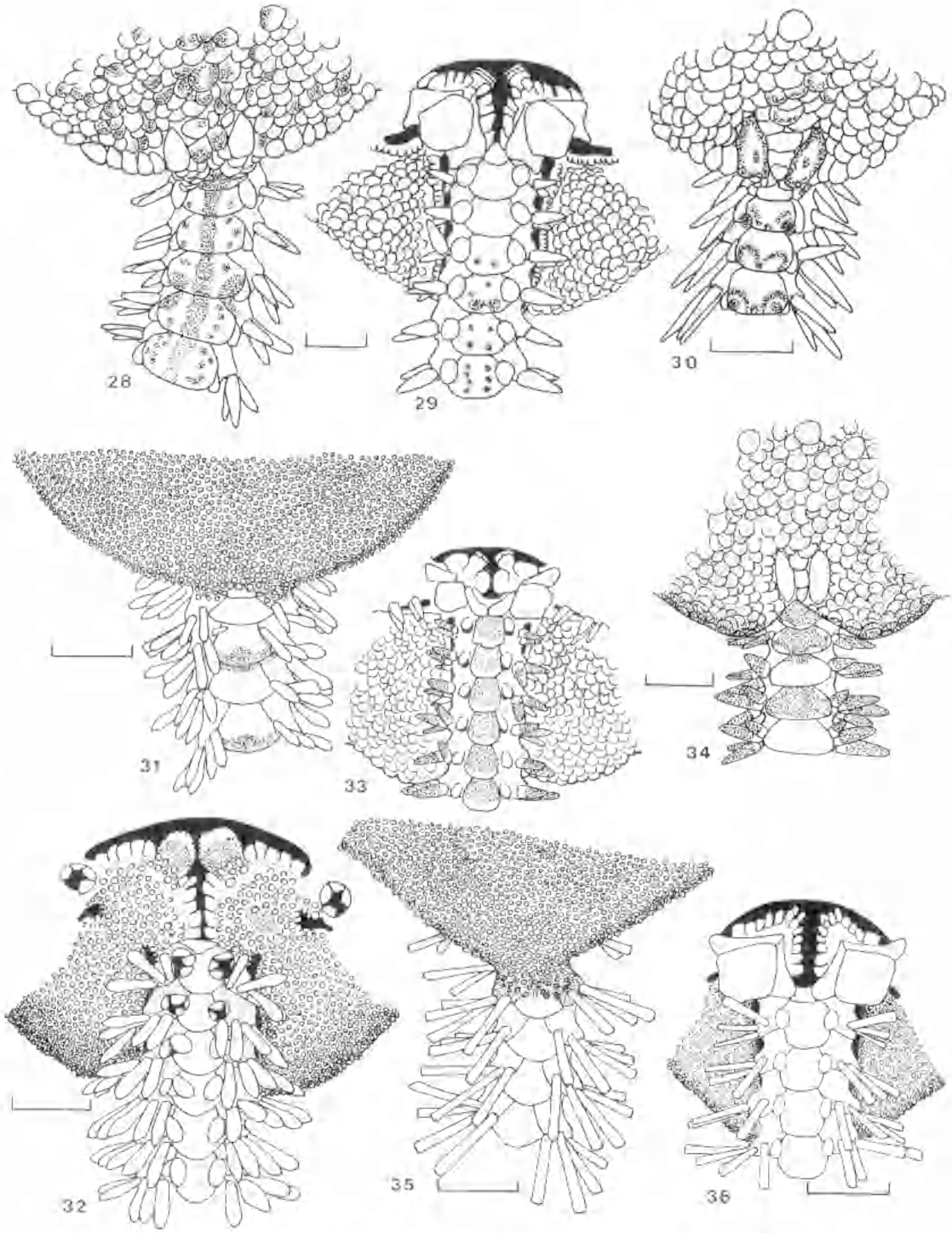
Description of holotype: Disc diameter 6.0 mm, arms broken but c.9 × d.d. Disc entirely covered with coarse imbricating scales, 3–4 in 1 mm radially; primaries prominent, and 1 central marginal inter-radial scale with 4 larger scales each side. Radial shields 0.9 mm long, 0.4 mm wide, divergent. Genital papillae small, granular, visible near arm bases dorsally.

Oral shields longer than wide, diamond-shaped with incurved disto-lateral margins. Adorals meeting within, attenuated distally. Distal oral papilla large, triangular, remaining 3 narrow, blunt.

Dorsal arm plates widest proximally, with evenly curved distal and proximal margins; supplementary plates very small and present throughout arm. Ventral arm plates widest distally, as long as wide, concave laterally, with



Figs 22–27. 22, arm base and adjoining disc, dorsal, of *Ophiomusium anisacanthum* (holotype SAM K254); 23, same, ventral, 24, 1st & 2nd lateral arm plates of SAM K254; 25, arm base and adjoining disc, dorsal, of *Ophiomusium australe* (holotype SAM K256); 26, same, ventral; 27, 1st & 2nd lateral arm plates of SAM K256. Scale line 0.5 mm.



Figs 28–36, arm bases and adjoining discs. 28 & 29, *Ophionereis lineata* (holotype, MCZ 5829) dorsal; & ventral; 30, *Ophionereis terba* n. sp. (holotype, NMV H363), dorsal; 31 & 32, *Ophioconis opacum* (NMNZ 2690) dorsal & ventral; 33 & 34, *Ophiuotis tricolor* (holotype SAM K213) ventral & dorsal; 35 & 36, *Ophiocomina australis* (BPBM W1822) dorsal & ventral. Scale lines 1.0 mm.

a straight distal margin curved only at the corners. Tentacle scales large, oval. Three slender, evenly tapered arm spines, middle spine longest, up to 2 × length of adjacent ventral arm plate.

Colour pattern (dry): disc mottled brown and cream, brown pigment around edges of disc scales and radial shields. Dorsal arm plates with m-shaped brown band on distal margin (Fig. 30); ventral surface uniformly cream.

Remarks: This species is closely related to *O. lineata* H. L. Clark from north Queensland waters. It differs from it (Figs 28–29) in having relatively longer and more slender arm spines—in *lineata* they are only slightly longer than an adjacent ventral armplate, and are thick for their length. Also, the oral shields of *O. terba* are symmetrically diamond-shaped rather than blunt, spearhead-shaped as in *O. lineata*. The colour patterns of these two species provide the most readily observable distinguishing features: *O. terba* has very prominent m-shaped brown bands across the distal part of the dorsal arm plates, and has a uniformly cream ventral arm surface, whereas *O. lineata* has a single longitudinal dark line on the arms dorsally, and random dark spots on both arm surfaces (Figs 28–29 of the holotype, MCZ 5829).

No depth was given for the collection site of *O. lineata* by Clark (1946), but the waters surrounding Lindeman Island are 37–55 m. The bathymetric range of the new species is, in contrast, 164–585 m.

Apart from its striking colour pattern, the new species is characterized within *Ophionereis* by the coarse disc scaling the very small supplementary dorsal arm plates. The trivial name *terba* is an Australian aboriginal word meaning pretty, and alludes to the colour pattern.

Ophiochiton Lyman, 1879

Ophiochiton lentus Lyman

Ophiochiton lentus Lyman, 1879: 55, pl. XIV, figs 398–400. Baker, 1979: 34.

Specimens examined: 3, NMV H368, 38°3.4′S, 149°23.7′E, E of Flinders Id, Bass Strait, 183 m, 22.xi.1973; 1, NMV H360, 39° 32.5′S, 148° 51.5′E, 274 m, 24.xi.1973.

Remarks: The specimens are 5.0–6.5 mm d.d. and differ slightly from the 13 mm holotype: the primary disc scales are prominent, there are no papillae along the edges of the genital slits, and there are two tentacles scales only on the first or second pore on each arm. These differences may be attributed to the juvenile nature of the specimens, for otherwise they agree closely with Lyman's description.

Ophiochiton lentus is the first representative of the genus to be found in Australian waters; the species is otherwise known from the type locality near the Kermadec Islands (also reported from there by Baker 1979) and the Chatham Rise, east of New Zealand in depths of 300–900 m.

Family Ophiocomidae

Ophiocomina Koehler, 1922

Ophiocomina australis H. L. Clark

FIGS 35, 36, 63–68

Ophiocomina australis H. L. Clark, 1928: fig. 124; 1946: 188; A. M. Clark, 1966: 327.

Specimens examined: Holotype, SAM K211, outer Gulf St Vincent S.A., no depth: 4 BPBM W1822, 2 km W of Outer Harbour, Gulf St Vincent S.A., among *Posidonia* roots, 12 m depth, 3.iii. 1965.

Remarks: The additional specimens from Gulf St Vincent are the first to be recorded since H. L. Clark's original description. They range 5–8 mm d.d. This rare species has a very restricted distribution in the South Australian gulfs—extensive collecting along other parts of the southern coast by S. A. Shepherd and Mrs J. E. Watson have failed to locate other examples. The holotype is in poor condition, and because the species has not been adequately illustrated, we give here figures of an 8 mm d.d. BPBM specimen (Figs 35–36), and SEM photographs of the oral plates, dental plate, vertebra, and arm spine (Figs 63–68).

Wilkie (1980) proposed that *Ophiocomina*, with the species *australis* and *nigra*, be placed in the family Ophiacanthidae. It is our opinion, that there are better grounds for continuing to retain this genus in the Ophiocomidae. Among these grounds are the features of *Ophiopteris*, *Clarkcoma*, and other ophiocomids which are also found in *Ophiocomina* (Table 1). Furthermore, differences rather than similarities between *Ophiocomina* and *Ophiolimna* spp. in terms of the length : height ratio of the oral plates, shape of the lateral arm plates and, at least in one species of *Ophiolimna* examined (*O.* cf. *perfida*), the presence of an oral calcified ridge to enclose the radial water canal in the 2nd rather than the 1st arm vertebra, are considered features that do not indicate family resemblance between the two genera.

TABLE 1. *Comparison of* Ophiocomina *with Ophiacanthids and Ophiocomids.*

	Ophiocomina	*Ophiopteris*	*Clarkcoma*	Ophiacanthids	Other ophiocomids
ORAL PLATES					
A. With radiating indentations on abradial muscle scar	−	−	−	−	+(−)[1]
B. Abradial muscle scar with flaring aboral wing	−	−	+	−	+
C. Adradial muscle scar less than (−), equal to (±), more than (+) half height of plate*	−	−	−	−, ±	+, −
D. Longer than high (+), equal (±), higher than long (−)	±, +	+	−	+	−, ±
E. Adradial articular area with upper distal edge rounded (+) or straight (−)	+	−	−	+, −	−
TEETH					
Hylinated tips	−	−	+	−	+
ARM SPINES					
Hollow (lumen more than half wall diameter)	+	−	+	+	−(+)[2]
DENTAL PLATE					
A. Foramina	−	+	+	−	+
B. Oral end widest	+	+	+	+, −	−(+)[3]
C. Papillae present	+	+	+	−(+)	+
RADIAL SHIELD AND GENITAL PLATE ARTICULATION					
Two condyles and one pit	+	+	+	+, −	+

* length = proximo-distal axis
height = oral-aboral axis

[1](−) for *Ophiocoma pusilla*, *Ophiopsila*, *Ophiocomella*

[2](+) for *O. pusilla* and *Ophiomastix ornata*.

[3](+) for *ophiocoma longispina*, *O. pusilla* and *Ophiomastix variabilis*.

FAMILY Ophiodermatidae

Genus *Ophioconis* Lütken, 1869

Ophioconis opacum (H. L. Clark) n.comb.

FIGS 31, 32

Ophiurodon opacum H. L. Clark, 1928: 440, figs 132a & b, 1946: 255; A. M. Clark, 1966: 327.

Specimens examined: Holotype, SAM K243, "St Vincent or Spencer Gulfs", S.A. no depth; 1, NMNZ 2122, Upper Spencer Gulf, S.A., 11 m, 4.ix.1973; 1, NMNZ 2690, Upper Spencer Gulf, S.A, 18 m, 11.ix.1973; 1, NMNZ 2123, off Glenelg, S.A., artificial reef site, 3–4 m, 1972; 1, NMNZ 2722, W of Outer Harbour Gulf St Vincent, S.A., 5 m, 3.i.1965; 2, BPBM W2220 & WAM 31–74, Cockburn Sd, W.A. under stones, 0–2 m, 13.ii.1972; 2, WAM 1133–74, 3.2 km NW Busselton Jetty, W.A., *Posidonia*, *Cymodocea* & sand, 22–24 m, no date.

Remarks: H. L. Clark (1946) referred three Australian species to *Ophiurodon*. *O. opacum* was separated from its northern congeners (*cincta* and *permixta*) by having blunter, flat opaque upper (at least) arm spines. However, A. M. Clark (1965) found no generic distinction after comparing the type species of *Ophioconis* (*O. forbesi*) with *permixta* and *cincta*. She did not consider *O. opacum* at that time and, in a 1966 key retained without comment *opacum* in *Ophiurodon*.

Comparison of specimens of the three known Australian species indicate they are indeed congeneric and should all be retained in *Ophioconis*. They share the following characters: longitudinally striated arm spines; more than two tentacle scales on proximal segments; broadened hyalinated usually serrated distal ends of teeth; adoral shields nearly or actually meeting in front of oral shield; disc granulae covering all or most of the oral shields as well as exposed part of oral plates.

The six specimens found since 1965 are the first recorded since the type description. They range 3.0–6.5 mm d.d., and their characters confirm the distinctness of this southern species of *Ophioconis*. It may be separated from the two northern Australian species by its flat, almost spatulate arm spines. Contrary to the

type description, *O. opacum* does have finely striated lateral arm plates but apart from that feature, the holotype and new material agree with H. L. Clark's description. Because H. L. Clark's illustration lacks detail, we give here a camera lucida drawing of NMNZ 2690 (Figs 31, 32) the holotype being not in a suitable condition for illustration.

The records of *O. opacum* from Western Australia extend the known range of the species westward from the South Australian gulfs; this extension and its shallow water habitat (0–24 m) indicate that it is probably more widespread on the southern coasts of Australia.

Bathypectinura H. L. Clark, 1909

Bathypectinura heros (Lyman)

Pectinura heros Lyman, 1879: 48 pl 14, figs 389–91.

Bathypectinura heros: H. L. Clark, 1909 129–30; Baker, 1979: 34.

Specimens examined: 1, SAM TK 3132, 37°58'–37°47'S, 139°49'–139°45'E, SW of Cape Buffon, S.A., 548 m, May, 1981; 2, NMV, 43 km SSW of Portland, Vic., 585 m, 14.V.1979.

Remarks: This large species (TK 3132 is 62 mm d.d.) has previously been recorded from off Bateman's Bay, New South Wales, and south of Norfolk Island (Baker 1979) in the Australian region. It has a worldwide distribution in 240–2960 m.

FAMILY Ophiacanthidae

Ophiacantha Müller & Troschel, 1842

Ophiacantha shepherdi n.sp.

FIGS 37, 38, 69–74

Specimens examined: Holotype, SAM K1750 & paratype BPBM W1831, Seal Rock, Encounter Bay, West Id, S.A., 24 m, on algae, coll. S.A. Shepherd, 18.ix.1967. Paratypes, 1, SAM E1749 & 1 NMNZ 3083, Deva Inlet, West Id, S.A., 18 m, coll. S.A. Shepherd, 24.vi.1967. Paratype, NMNZ, 11 km off Glenelg, Gulf St Vincent, S.A., 25 m, coll. S.A. Shepherd, 27.xii.1966. Paratypes, 8, NMNZ 3085, 2, BPBM W1835, Land's End, West Id, S.A., 17–18 m, coll. S.A. Shepherd, 1967. Paratypes, 2, BPBM 1839, Seal Rock, West Id, SA., 24 m, coll. S.A. Shepherd, 5.ii.1967. Paratypes, 2, WAM, 19–81, Oedipus Pt, West Id, S.A., 15 m, coll. S.A. Shepherd, no date; Paratypes, 1, AM, 1, BM(NH), 4, NMNZ 3641, Middle Pt, Cape Northumberland, S.A., 13 m, in algae, coll. S.A. Shepherd, 19.iii.1974.

Description of holotype: Disc diameter 2.5 mm; arm length 11–12 mm, arms taper gradually. Upper side of disc with very low conical granules (rarely as high as broad), slightly larger and more prominent interradially than radially; granules generally not contiguous, underlying scales evident between them. Radial shields sock-shaped, distal ends exposed and adjacent to lateral edge of first exposed dorsal arm plate; also in contact with genital plate below. On lower side of disc, granules more widely spaced proximally; disc scales evident.

Oral shields approximately 1.5 × broader than long, somewhat triangular, with small lobe in distal edge, madreporitic plate much larger, with greater distal prominance. Adoral shields large, meeting broadly within, encroaching distad around most of ventral shield.

Three oral papillae on edge of oral plate; outer two longer than broad, similar in size to inner papilla which is more sharply tapered and apically directed. The first tooth level with oral papillae but larger and arrow-head shaped, other teeth not visible.

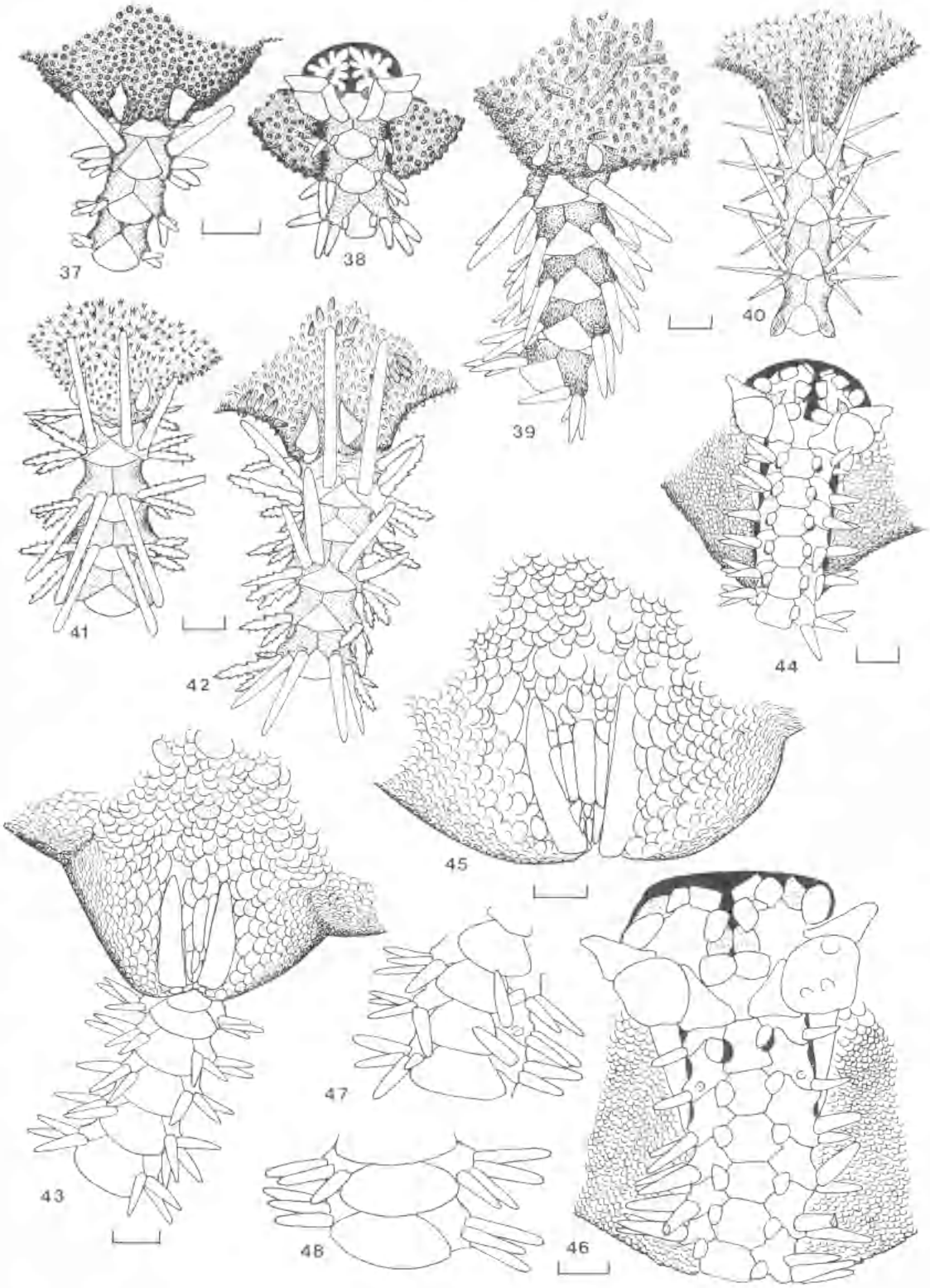
First ventral arm plates slightly broader than following plates which are fan-shaped, with the distal edge convex (Fig. 69); plates separated from one another by lateral arm plates, the separation increasing distally.

One tentacle scale, less than ½ a segment long, rectangular with rounded tip (Fig. 70); scales remaining approximately same size and shape on distal segments in contrast to diminishing size of other arm plates.

Dorsal arm plates broadly fan shaped, 1.5 × or more broader than long; with exception of the first exposed plate which is in contact with second plate, all others separated from each other by lateral plates. Micro- structure of these plates is a close mesh of pores and trabeculae, with smooth raised lumps at intersections of meshes (Figs 71, 72).

Lateral arm plates meeting broadly above and below; distal edge flaired considerably where arm spines attached. Two short and 3 somewhat longer bluntly rounded spines on segments one and two respectively; segment three (first free segment) with 4 arm spines, the lower three being somewhat longer than those of segment two, minutely spiculate and gently tapering, while upper spine on each side is greatly enlarged, 2 × length of adjacent lower spine (750 mμ vs. 350 mμ) and nearly twice as thick, microscopically rugose, scarcely tapering, and broadly rounded at tip (Fig. 73). One of 10 sides with only 3 arm spines, the upper enlarged spine being absent.

Three spines (rarely 4) continue on distal segments, the spines remaining short, blunt, in-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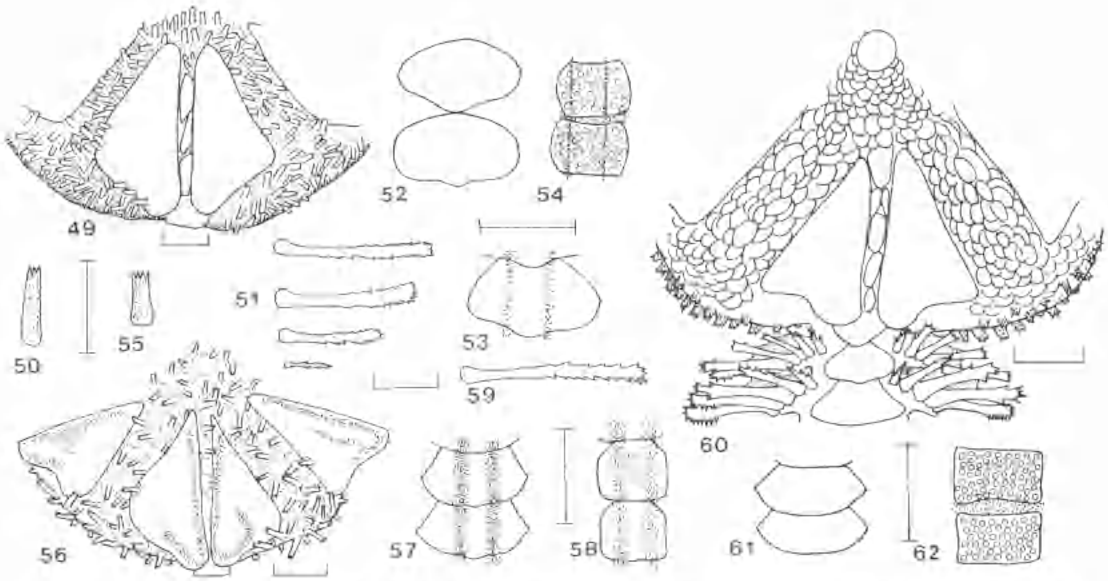


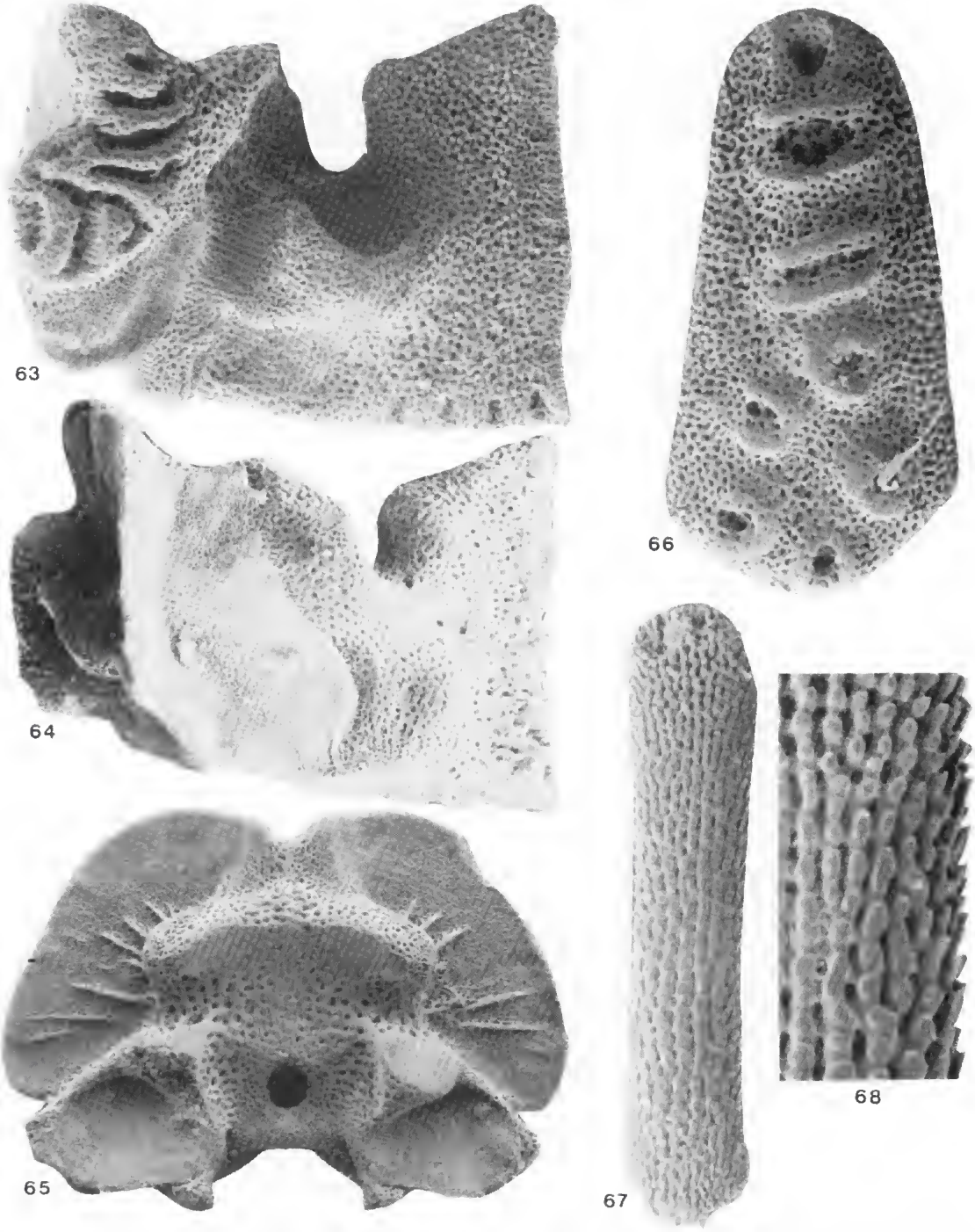
Figs 49–62. 49–54, *Ophiothrix (Placophiothrix) albostriata* (holotype, SAM K215): 49, radial disc segment, dorsal; 50, disc stump; 51, representative arm spines; 52, 5th & 6th dorsal arm plates; 53, 20th dorsal arm plate with pigment; 54, 9th & 10th ventral arm plates. 55–59, *Ophiothrix (Placophiothrix) lineocaerulea* (holotype, SAM K218): 55, disc stump; 56, radial disc segment, dorsal; 57, 5th & 6th dorsal arm plates with pigment; 58, 9th & 10th ventral arm plates with pigment; 59, uppermost basal arm spine. 60–62, *Ophiothrix (Keystonea) hymenacantha* (holotype, SAM K217): 60, arm base and adjoining disc, dorsal; 61, 5th & 6th dorsal arm plates; 62, 9th & 10th ventral arm plates. Scale lines 1.0 mm.

creasingly spiculate, and near end becoming dentate along one margin (Fig. 74).

Variation. A paratype (BPBM W1831) from the same station as the holotype is the largest specimen (d.d. of 2.7 mm). The arms are contorted and twisted upward making the upper side difficult to see. However, the lower (oral) surface, especially the mouth region, is fully exposed. In contrast to the holotype, this specimen has the adoral shields separated in front of the oral shields, probably due to the flexure of the upwardly directed arms. The teeth are visible, there being 2 or 3 below the apical one, somewhat blunt to slightly tapered or, in two cases, the upper being elongate and pointed. At the inner radial edge of each side of the ventral arm shield there is a small papilla which is separate from either the adoral shield or jaw plate. None of the other specimens has this feature. An arm spine sequence of 2–3–4–3–3 is typical on the first five proximal segments. Four arm spines occur very infrequently (seg. 6, on one side of one arm and seg. 7, on both sides of one arm, one side on another) but in no case are these enlarged like those on segment 3. The smallest specimen (d.d. 1.5 mm) shows only a few sides of segment 3 with the fourth spine developed and only on two sides are these enlarged. The largest specimen has a few enlarged granules about as high as broad located in the inter-radial oral region. It is quite evident that a distal lobe of each adoral shield separates the oral shield from the first lateral arm plates in this specimen. In the holotype this lobe is not as well developed and the oral shields touch the first laterals.

Remarks: Ophiacantha shepherdi differs from congeners in having the combination of low

Figs 37–48. 37, arm base and adjoining disc, dorsal, of *Ophiacantha shepherdi* n. sp. (holotype, SAM K1750); 38, same, ventral; 39–42, arm bases and adjoining discs, dorsal, of: 39, *Ophiacantha heteroryla* (NMNZ 2071); 40, *Ophiacantha brachygnatha* (NMNZ 2070); 41, *Ophiacantha clavigera* (NMNZ 2072); 42, *Ophiacantha alternata* (NMNZ 2087); 43, arm base and adjoining disc, dorsal, of *Amphiura trisacantha* (NMNZ 2073); 44, same, ventral; 45, radial disc segment, dorsal, of *Amphiura trisacantha* (holotype, SAM K212); 46, same, ventral; 47 & 48, basal, & 9th & 10th arm segments of *A. trisacantha*, holotype. Scale line 0.5 mm.



Figs 63–68. *Ophiocomina australis* (BPBM W1822): 63, oral plate, adradial view, x81; 64, oral plate, abradial view, x72; 65, 1st arm vertebra, x187; 66, dental plate, x117; 67, arm spine, x89; 68, edge of arm spine, x250.

blunt disc granules and only one pair of smooth, elongate and enlarged upper arm spines on the segment next to the disc. The granules on *O. shepherdi* are rarely as high as broad (spinules are defined as disc elements 2 × as high as broad, with granules up to 2 × or less as high as broad, with blunt tips). Whereas *O. gracilis* (Studer) shows a similar pronounced elongation of one pair of basal upper arm spines, these and other arm spines differ from those of *O. shepherdi* by being acutely tapered to sharp points, and the disc covered by delicate multifid pointed disc elements. *O. alternata* A. M. Clark, which has been collected with *O. shepherdi*, differs by having short conical granules mixed with longer, thicker blunt spinules on the disc, an alternating sequence of arm spines, and segment 1 with three, or sometimes four, arm spines (vs. two, rarely three, on this segment in *O. shepherdi*). *O. heterotyla* H. L. Clark, in contrast to *O. shepherdi*, carries five rather than four spines on the basal free segment and the upper arm spine of the first free basal segment is much less than twice that of the preceding spine in the row, and all the spines taper evenly towards the tip.

O. shepherdi is further characterized by having microscopically smooth dorsal arm plate trabeculae on fan-shaped plates, oral shields which are separated from the first lateral arm plates by a distal lobe of the adoral shields (at least in the largest specimens), and short (except for one pair of upper), few (not more than four) smooth arm spines, the rows not approximate dorsally.

This species is named for its collector, Mr S. A. Shepherd.

Ophiacantha heterotyla H. L. Clark
FIGS 39, 75–78

Ophiacantha heterotyla H. L. Clark, 1909: 542, pl. 52, figs 4–6; 1918: 86; 1938: 209; 1946: 184.

Specimen examined: 1, NMNZ 2071, off Simpson's Bay, Bruny Id, Tas., 11 m, 18.ix.1972.

Remarks: About average size for this species (3.5 d.d., 13.0 mm arm length). Stout, rather club-shaped disc spinelets characteristic of *O. heterotyla* reach 0.5 mm long and are prominent radially between the radial shields and the disc centre. Elsewhere, the disc is covered by small, round, glassy plates bearing short, blunt stumps. There are 5 or 6 arm spines on the first two or three free arm segments, then 4 spines over the remainder of the arm. The spines are stout, cylindrical, and the uppermost are initially the longest (Fig. 39), those on the first two segments being up to 2½ arm segments long. After the 8th or 10th arm segment the lowermost spine is noticeably shorter than the other three. The micro-structure of the arm spines consists of a longitudinal series of granule-bearing, divaricating ridges separated by grooves and hollows (Fig. 75). The dorsal and ventral arm plates are roughly triangular and have a micro-structure similar to, but more random than, that of the arm spines (Figs 76–78). The tiny granules are not present on the ventral plates (Fig. 77).

Ophiacantha heterotyla is closely related to *O. alternata* and *O. shepherdi*. From the former it is distinguished by having a non-alternating number of arm spines on successive arm segments, and taller disc elements. From *O. shepherdi*, it differs in the greater number and size of basal arm spines, and the tall spinelets rather than low granules on the disc. The microstructure of the arm plates is closer to *O. alternata* than to the other South Australian congeners (Figs 78, 89).

O. heterotyla apparently has a restricted distribution from Sydney to Bruny Id, Tasmania in 9–146 m.

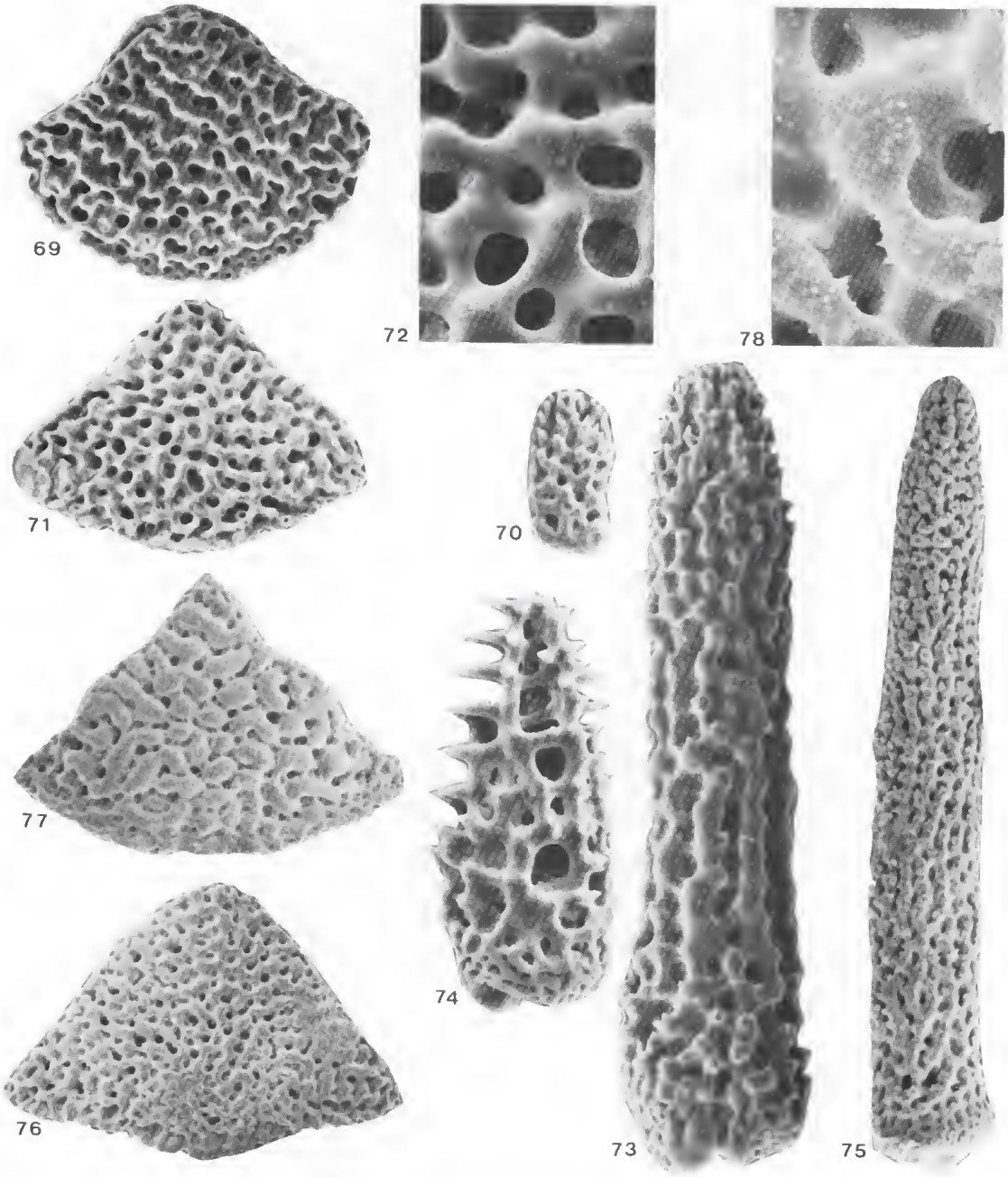
Ophiacantha alternata A. M. Clark
FIGS 42, 84-82

Ophiacantha alternata A. M. Clark, 1966: 328–330, Figs 4a–c.

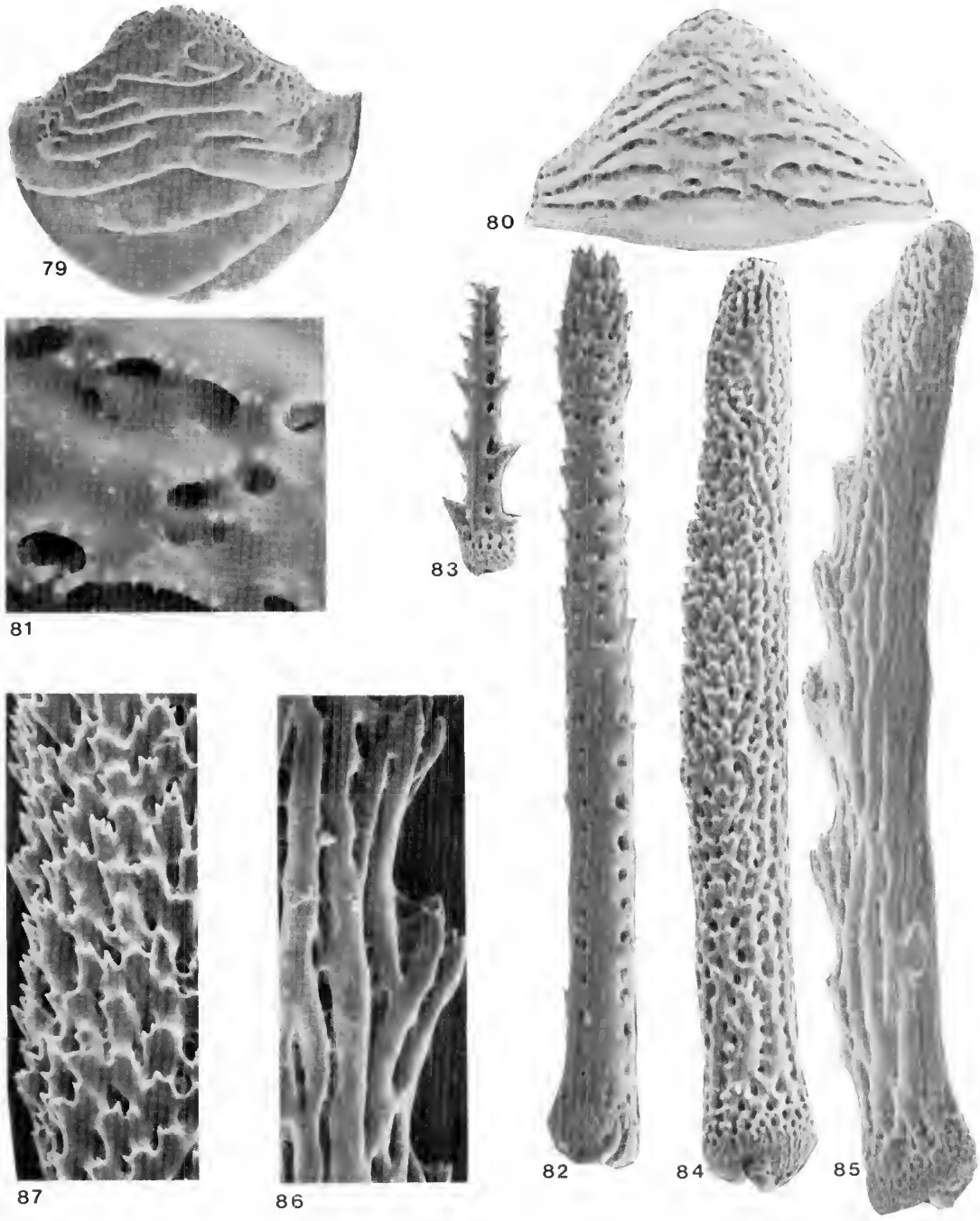
Ophiacantha clavigera Koehler: H. L. Clark, 1938: 208 (Koombana Bay, Bunbury, Western Australia—part).

Specimens examined: Paratypes, 3, NMV H16, Port Phillip Bay, Vic., 5.5–12 m 21.v.1961; 1, WAM 634–78, Arrawarra, N of Coffs Hbr, N.S.W., tide pool, 20.iii.1978; 1, NMNZ 2114, Port Hacking, N.S.W., 7 m, 30.v.1976; 6, NMNZ 2379, Erith Id, Kent Group, Bass Strait, 50 m, 6.v.1974; 1, NMNZ 2116, Westernport, Vic., 3 m, 2.v.1976; 2, NMNZ 2099, off Pt Marsden, S.A., 20 m, Jan., 1965; 12, NMNZ 2093–96, West Id, S.A. 2–27 m, 19.iii.1966–18.ix.1967; 1, BPBM W1810, 8 km N of Western River, Investigator Strait, S.A., 45 m, 12.i.1965; 4, NMNZ 2098, 11 km off Glenelg, S.A., 25 m, 27.xii.1966; 2, NMNZ 2100, Eagle Bay, Cape Naturaliste, W.A., 1–5 m, 24.ii.1975; 2, WAM 259–71, BPBM W2208, Cockburn Sound, W.A., no depth, 28.v.1958; 2, MCZ 4900, Koombana Bay, Bunbury W.A., no depth, 26.x.1929 (det. *O. clavigera* by H. L. Clark, 1938).

Remarks: Hitherto this species was known only from Port Phillip Bay, Victoria; the new



Figs 69–78. 69–74, *Ophiacantha shepherdi* (paratype NMNZ 3085): 69, 2nd ventral arm plate, x128; 70, tentacle scale x145; 71, 2nd dorsal arm plate, x108; 72, surface detail of 71, x435; 73, uppermost basal arm spine, x145; 74, distal arm spine, x217. 75–78, *Ophiacantha heterotyla* (NMNZ 2071): 75, uppermost basal arm spine, x72; 76, 2nd dorsal arm plate x72; 77, 2nd ventral arm plate, x77; 78, surface detail of 76, x580.



Figs 79–87. 79–83, *Ophiacantha clavigera* (NMNZ 2015): 79, 2nd ventral arm plate, x138; 80, 2nd dorsal arm plate, x136; 81, surface detail of 80, x 544; 82, uppermost basal arm spine, x90; 83, middle basal arm spine, x86. 84–87, *Ophiacantha alternata* (NMNZ 2097 & 2099): 84, uppermost basal arm spine of 2097, x80; 85, uppermost basal arm spine of 2099, x74; 86, surface detail of 85, x150; 87, surface detail of 84, x150.

material shows a wide southern Australian distribution from Coffs Harbour, N.S.W. (30° 18'S) to Cockburn Sound, W.A. (31°57'S) in 1–45 m. This distribution pattern is shared by a number of endemic shallow water ophiuroids (*Conocladus australis*, *Clarkcoma canaliculata*, *Ophiopeza assimilis*, *Ophiarachnella ramsayi*, *Ophiothrix (Placophiothrix) spongicola*), and supports the concept of a single southern faunal region in Australian coastal waters.

Ophiacantha alternata varies remarkably in the shape of its arm spines. The macroscopic appearance of the spines ranges from smooth to broadly serrate on one side (Figs 84, 85). The uppermost basal spines are usually more or less straight when smooth, although the tips may be slightly clavate or even bifurcate in rare cases. The laterally serrate spines are, however, invariably curved in a sabre-like fashion (Fig. 85). Microscopically, the spines are sculptured in two ways—the basal portions being an anastomosing system of smooth longitudinal ridges and pores (Fig. 86), whereas the distal portions are finely rugose, the ridges having become finely but irregularly covered with raised lumps bearing small thorns (Fig. 87). When present, the broadly serrate spines occur on all arms; and the adjacent smaller spines are similarly serrate, but bear teeth on both edges rather than one (Fig. 91). Were it not for the absence of another constantly different character, and the fact that individuals with smooth spines occur in samples with those bearing serrate spines, these two forms could be mistaken for separate species. In other respects specimens are alike. The microstructure of the dorsal arm plates is similar to *O. heterotyla*, with fine rugosities scattered over enlarged sections of the trabeculae (Figs 88, 90), but that species can be distinguished from *O. alternata* because of the latter's alternating sequence of arm spines, a typical sequence being 3-3-7-8-5-7-5-6-4-6 on the proximal segments (NMV H16).

The radial shields of *O. alternata* are, like those of *heterotyla* and *shepherdi*, exposed only at their distal tips. The shape of these shields is unusual—they are "sock-like" (Fig. 92) rather than the long narrow and "bar-like" shields apparently typical of *Ophiacantha*.

Ophiacantha clavigera Koehler

FIGS 41, 79–83

Ophiacantha clavigera Koehler, 1907: 247, figs 1–3.– H. L. Clark 1938: 208 (in part); 1946: 184 (in part).– A. M. Clark, 1966: 330.

Specimens examined: 3, NMNZ 2105, 2089, 2373, Seal Rock, West Id, S.A., 16–27 m, Mar. & Aug., 1966, Feb., 1967; 1, NMNZ 2374, 11 km off Glenelg, S.A., 25 m, 27.xii.1966; 1, NMNZ 2085, off Waldengrave Id, Great Australian Bight, 23 m, 11.v.1971; 1, ZMH E2016 (herein designated lectotype), Stn 51, Cockburn Sd, S Channel, rocky bottom, 6.5–8 m, 30.ix.1905; 3, ZMH E6594, 2, MNB 4560, 1, WAM 4416 (herein designated paralectotypes), Stn 56, Koombana Bay, 9.6 or 11.2 km SW of Bunbury, W.A., rocky bottom with sparse plant growth, 14.5–18 m depth, 28.vi.1905; 1, ZMH E6123, Stn 50, Cockburn Sd, Southern Flats, seaweed, 3–4 m, 30.ix.1905; 5, MCZ 4900, Koombana Bay, W.A. no depth, 26.x.1929; 1, WAM 17–81, 11 km SW Bunbury, W.A., 20 m depth, 13.iv.1963; 5, NMNZ 3106, off Carnac Id, W.A., 7.5 m, 21.iii.1972; 1, WAM 517–77, 27 km W of Cape Peron, W.A., 35 m, 29.vi.1977; 1, WAM 18–81, ca.18 km N of Dongara, W.A., 18.3 m, 16.ii.1976; 1, MCZ 4901, Broome, W.A., dredged, no depth, June 1929.

Remarks: The specimens range 1.5–3.5 mm d.d., with arms 4–5 × d.d. long, and agree well with Koehler's description and rather diagrammatic figures. The South Australian records are an extension of the species' range eastward from Western Australia where it has been reported from Cockburn Sound, Koombana Bay, and Broome (Koehler 1907, H. L. Clark 1938).

New morphological information on this species is now available from SEM examination of arm plates and spines (Figs 79–83). The surface of the ventral arm plates consists of a series of broad, smooth, transverse "shelves", beneath the edges of which are minute pores (Fig. 79). The dorsal arm plates have similar shelves, but they are somewhat crowded and irregular, and their edges bear minute thorns (Figs 80, 81). The longest upper arm spines are cylindrical and smooth basally, with two longitudinal rows of pores running towards a slightly swollen and thorny tip (Fig. 82). The lower arm spines are flattish, with a single row of pores, and strong teeth on their edges (Fig. 83). These features, plus a non-alternating sequence of arm spines, and forked, thorny disc elements, characterize *O. clavigera*.

Eight of the 11 specimens reported as *Ophiacantha clavigera* by H. L. Clark (1938) from Koombana Bay, Bunbury, and one from Broome were lent by MCZ. Three of the Koombana Bay specimens with d.d. 1.7 to 3.5 mm can be assigned to *O. alternata* A. M. Clark. They are easily distinguished from the other five by having a well defined alternating sequence of arm spines and conical, tuberculate

disc elements. Examination of the type specimens of *O. clavigera* in ZMH and MNB reveals the very characteristic thorny forked disc elements as originally shown by Koehler, noticeably white curved radial shields, and non-alternating sequence of arm spines. These characters are evident on the five other MCZ specimens reported by H. L. Clark as *O. clavigera* from Koombana Bay.

H. L. Clark's confusion between *O. clavigera* and *O. alternata* led to an error in his 1946 key to Australian *Ophiacantha* species. He considered *O. clavigera* among those species having the disc covered by coarse granules and short blunt spinules, and only the first free segment with long upper arm spines. *O. clavigera*, as Koehler figured clearly, has delicate, slender, forked disc spinules and elongate, often claviform (towards the tip), upper arm spines on at least four segments beyond the disc (Figs 41, 82).

In addition to failing to note the presence of a regularly alternating arm spine sequence for several of the specimens from Koombana Bay, H. L. Clark (1938) considered that *O. clavigera* exhibited "growth changes" with respect to the nature of the disc elements, remarking that "the disc spinelets tipped with 2 or 3 glassy teeth gradually lose those tips and become changed into little sugar-loaf shaped tubercles." In fact, however, one of these specimens with a d.d. of 1.7 mm, having conical tubercles and an alternating arm spine sequence, is smaller than several with forked thorny disc elements and non-alternating arm spines, and is unquestionably *O. alternata*. On no individual of *O. clavigera* examined does a mixture of the two kinds of disc elements occur.

Ripe orange gonads were observed protruding from a rupture below several radial shields in a 2.0 mm specimen (MCX 4900).

This species occurs mostly on algae in rocky areas, from the shallow sub-littoral to a known maximum depth of 35 m.

Lectotype designation. Koehler (1907, p. 247) reported "deux petits echantillons" from Cockburn Sound (Stn 51) and "cinq petits echantillons" from Koombana Bay (Stn 56). ZMH has 3 specimens labelled "Paratypes", MNB has 2 labelled "Types", and WAM has one labelled "Holotype", all from Stn 56. ZMH also has 1 specimen labelled "Holotype" from Stn 51 and 1 from Stn 50 labelled as "Cotype". Although Koehler did not select a holotype in his original description of *Ophiacantha clavigera*, he mentioned the largest example from Cockburn Sound was 2.5 mm d.d. and, judging from the scale given, his Fig. 1 is of a specimen approximately that size. We have selected the ZMH specimen (E2016) from Stn 51 as lectotype because with a d.d. of 2.7 mm, it conforms closely with the size and original description, and remains in good condition in alcohol. The other specimens mentioned above are all smaller than 2.5 mm, and that from WAM is badly decalcified.

Paralectotype designation is established for the ZMH, MNB and WAM specimens from Stn 56 although it is not possible to resolve the discrepancy in number of individuals from Stn 56 (5 reported, 6 in collections). One of these might be one of the two presently not located from Stn 51. Cockburn Sound is now the type locality. The specimen from Stn 50 at ZMH with d.d. 2.0 mm has no type status.

Ophiacantha brachygnatha H. L. Clark

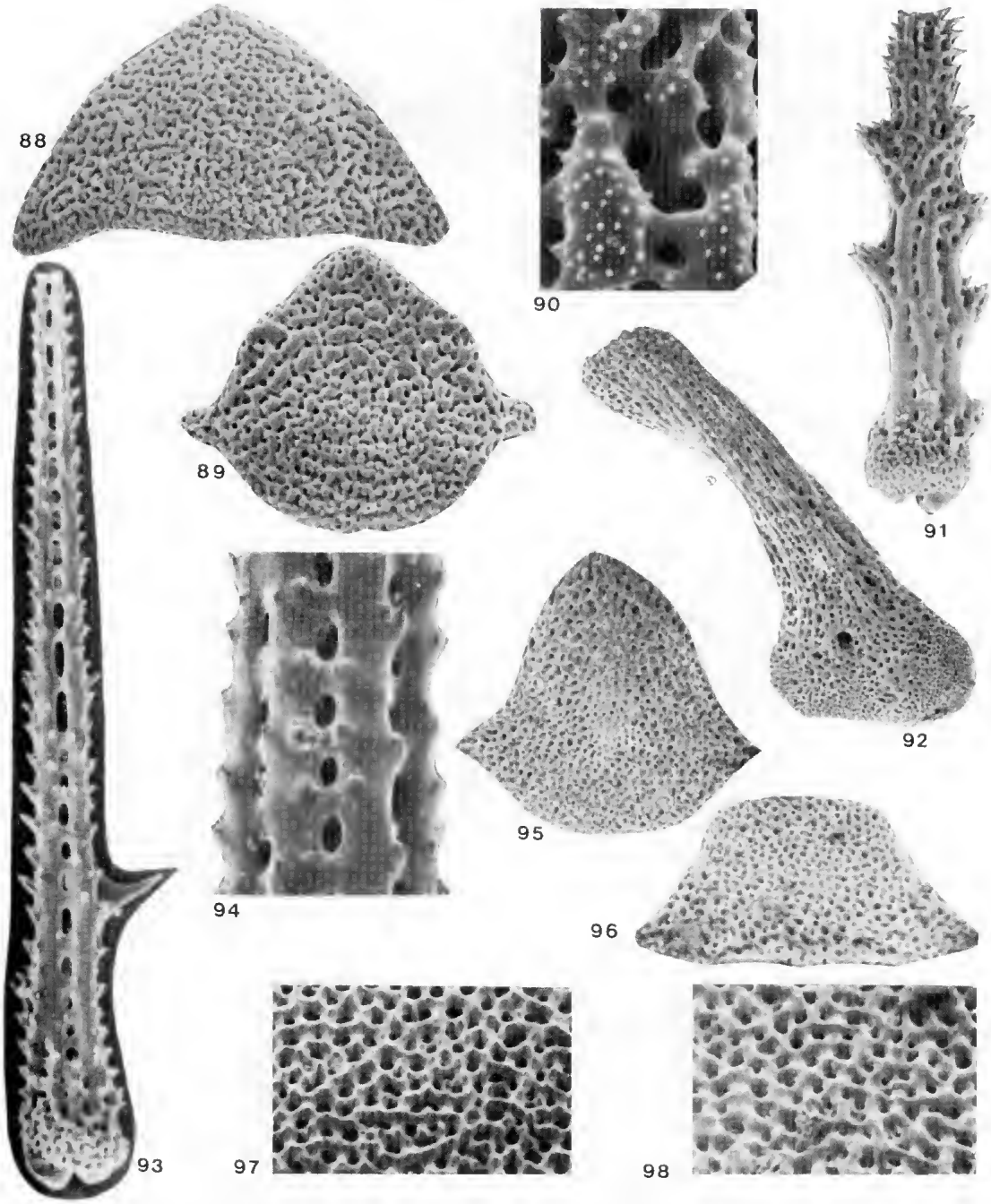
FIGS 40, 93–98

Ophiacantha brachygnatha H. L. Clark, 1928: 420, figs 123a & b; 1946: 186.

Ophiacantha abyssicola G. O. Sars var. *otagoensis* Fell, 1958: 25 pl. 4, figs, G, L.

Specimens examined: Holotype SAM K208, St Vincent or Spencer Gulfs, S.A., no date or depth; paratype, MCZ 4611, same locality data as holotype; 6, NMNZ 2084, S of Warrnambool, Vic., 220–310 m, 14.v.1969; 3, NMV H359, 39°44.5′S, 148°49′E, Bass Strait, 640 m, 24.xi. 1973; 1, NMNZ 3570, West Id, S.A., 2 m, no date. 1, WAM 844–78, 31°45′S, 115°02′E, NW Rottnest Id, W.A., 265–276 m, 18.iii.1972; 8, WAM 235–78, + 3, BPBM W2597, 33°30′S, 114°31′E, W of Cape Naturaliste, W.A., 250–237 m 15.iii.1972; 1, WAM 222–78, 27°18′S, 114°06′E, NW of Bluff Pt, W.A., 99 m, no date; 10, NMNZ 2784, 45°46′S, 171°05′E, off Otago, N.Z., 660–600 m, 1974.

Remarks: Hitherto this species was known from the two type specimens from Spencer or St Vincent Gulfs. The new material, providing extensions eastward to Victoria, and New Zealand, and westward to Western Australia, is smaller (1.8–4.5 mm d.d., arms <6 × d.d.) than the holotype but agrees with it in all other details. *O. brachygnatha* is characterized by a disc cover of thin-stalked, flared multifid spinelets, moniliform arms bearing bell-shaped dorsal arm plates, and 5–7 narrow, tapering, finely serrated arm spines. The microstructure of the arm spines consists of parallel, longitudinal toothed ridges separated by single series



Figs 88–98. 88–92, *Ophiacantha alternata* (NMNZ 2099): 88, 2nd dorsal arm plate, x90; 89, 2nd ventral arm plate, x90; 90, surface detail of 88, x360; 91, middle basal arm spine, x72; 92, radial shield, x 40. 93–98, *Ophiacantha brachygnatha* (NMNZ 2084 & 2034): 93, uppermost basal arm spine of 2084, x96; 94, surface detail of arm spine from 2034, x150; 95, 3rd dorsal arm plate of 2034, x100; 96, 2nd ventral arm plate of 2034, x80; 97, surface detail of 95, x100; 98, surface detail of 96, x100.

of evenly spaced perforations (Fig. 94). There is sometimes one large tooth on the abradial side of the largest spines, situated at about .3 of the spine length (Fig. 93). The external surfaces of the dorsal and ventral arm plates (Figs 95–96) are covered with perforations and trabeculae bearing sharp points and smooth lumps, respectively (Figs 97–98).

Ophiacantha abyssicola var. *otagoensis* from New Zealand, is a synonym of this species, but *O. abyssicola* s. str. appears to differ mainly in the characteristic cross-shape of its oral shields, compared to the simple triangular shields of *O. brachygnatha*.

Ophiacantha yaldwyni Fell

Ophiacantha yaldwyni Fell, 1958: 23, pl. 4, figs F, H, I.

Specimens examined: 1, NMV H361, 38°24.5′S, 149°25.5′E, off Pt Hicks Vic., 823 m, coral rock 21.xi.1973; 2, NMNZ 2658, 42°29′S, 173°37′E, Kaikoura Canyon, N.Z., 1097–1006 m, 18.iii.1976.

Remarks: This species was previously known from a single specimen taken in Cook Strait, N.Z., at 1005 m (Fell 1958), and the Victorian record is thus new for Australia. The specimens are slightly smaller (6–9 mm d.d.), but agree very closely with Fell's description. Fell recorded an absence of tentacle scales after the fourth arm segment in the holotype; the present material does not conform in that respect, the tentacle scales persist along most of the arms as thin spikes with three terminal thorns. *O. yaldwyni* is otherwise characterized by a disc cover of evenly spaced thorny granules, six robust arm spines with asymmetric and largely terminal thorns, 5–9 irregularly arranged, club-shaped oral papillae, and rhomboidal oral shields. The type specimen cannot be located and is feared lost.

Key to southern Australian species of *Ophiacantha**

1. Disc covered dorsally by slender, multifid spinelets 2
   Disc covered dorsally by granules or spinules 3
2. Dorsal arm plates triangular; longest armspines clavate ..... *O. clavigera*
   Dorsal arm plates bell-shaped, longest armspines evenly tapered ..... *O. brachygnatha*
3. Disc covered dorsally by granules 4
   Disc covered dorsally by spinules 5
4. Disc granules as wide or wider than high, blunt; first uppermost armspine enlarged ..... *O. shepherdi*
   Disc granules as high or higher than wide, with terminal thorns, uppermost armspines of similar size ..... *O. yaldwyni*
5. Disc with pointed spinules, enlarged inter-radially near disc margin; arm spines alternating in number ..... *O. alternata*
   Disc with pointed spinules enlarged near disc centre; armspines not alternating in number ..... *O. heterotyla*

Ophioprium rosea (Lyman) n. comb.

Ophiacantha rosea Lyman, 1879: 139, pl. X, figs 267, 268; 1882: 184, pl. 25, figs 10, 11.– Fell, 1958: 23, pl. 4, figs J, K.–McKnight, 1967: 308.

Ophiacantha truncata Koehler, 1930: 62, pl. VI, figs 13–14.

Specimens examined: Holotype, BM(NH) 82.12.23.175, 50°10′S, 74°42′W, S Indian Ocean, 320 m, 5.I.1876 (Challenger Sth 308); 11, NMV H364 & 1, NMNZ 2654, 39°44.5′S, 148°49′E, Bass Strait, 640 m, 24.xi.1973; 2, NMNZ 2655, 43°14′S, 173°39′E, Pegasus Bay, N.Z., 1006–512 m, 27.ix.1976; 1, ZMC, 38°15′S, 149°20′E, S of Cape Everard, Vic., 270–470 m, 19.ix.1914 (holotype of *Ophiacantha truncata* Koehler).

Remarks: This robust, brightly coloured species has been recorded from New Zealand by Fell (1958) and McKnight (1967), and southern Chile, Japan, and Crozet Is. by Lyman (1879, 1882), thus its occurrence in Australian waters is not unexpected.

The new material ranges 7–15 mm d.d., and has arms about 4 × d.d. At their bases, the arms of a 12 mm d.d. specimen are 4 mm high and 3 mm wide, with 10 arm spines up to 4 mm long. The arms therefore have a very robust appearance. The disc is covered entirely with small thorny stumps up to 3 × higher than wide. There are 18 oral papillae on each jaw, 6 internal and the remainder external on each side. The internal papillae are rather spini-

* Other species recorded from southern Australian waters and referred to *Ophiacantha* by H. L. Clark (1946) are here regarded as belonging to different genera, viz: *Ophiacantha truncata* = *Ophioprium rosea* (Lyman); *Ophiacantha fidelis* = *Ophiomitrella fidelis* Koehler; *Ophiacantha congesta* = *Ophiacaea congesta* (Koehler); *Ophiacantha valenciennesi* = *Ophiotreta valenciennesi* (Lyman).

form, whereas the external ones are spatulate. The oral shield is of an unusual bell-shape, with the apex of the bell pointing distally. There is one very large paddle-shaped tentacle scale on each pore except the first, where there are occasionally two (as in the holotype).

The concealed radial shields, numerous oral papillae generally of two distinct types and position, two basal tentacle scales, and following single scale of very large size, indicate that this species should be placed in *Ophioprium* H. L. Clark rather than *Ophiacantha*. In other respects, such as size, form and sculpturing of arm spines, and the nature of the arm plates, *O. rosea* closely resembles the two large species of *Ophioprium* (*O. larissae* and *O. kapalae*) known from the Tasman Sea (Baker 1979). *O. rosea* is distinguished by its red colour, short arms, and the shape of its oral shields and tentacle scales.

Ophiacantha truncata Koehler, known from two specimens from just northeast of Tasmania, is here regarded as a junior synonym of *O. rosea*. The holotype has identical disc stumps, arm spines, arm plates, and oral shields, and up to 17 oral papillae of two kinds. The five arm bases have only one large tentacle scale to each pore indicating that the presence of more than one scale is not a stable character.

Ophioplinthaca Verrill, 1899

Ophioplinthaca incisa (Lyman)

Ophiomitra incisa Lyman, 1883: 263, pl. VI, figs 89, 90.

Ophioplinthaca incisa Verrill, 1899: 351.– H. L. Clark, 1915: 211.

Specimens examined: 8, NMV H361, 38°24.5'S, 149°25.5'E, S of Pt Hicks, Vic., 823 m, rock and coral, 21.xi.1973.

Remarks: The discovery of this species in the waters of southern Australia is somewhat surprising considering that all previous records have been from western Atlantic Ocean near Barbados and Dominica. Its bathymetric range of 610–1572 m, suggests however, that it may well be widespread like some other deep continental slope ophiuroids.

The largest specimen is 17 mm d.d., and one has what is possibly a dwarf male attached to its aboral surface. The specimens match Lyman's description closely, and the range of sizes shows small variations: the arm spines vary from five to seven, and the disc cover varies from smooth stumps at the edge to thorny stumps near the disc centre.

Ophioplinthaca is cosmopolitan on the continental shelf or deeper, and contains about 30 nominal species. No representative has hitherto been recorded from Australia, although several are known from Indonesian waters (Koehler 1930). Of those, *O. vicina* Koehler from the Banda Sea, 1595 m, is very close to this species. It is known from a single specimen, and appears to differ mainly in the shape of the oral shields and the alignment of the external oral papillae.

FAMILY *Ophiactidae*

Ophiactis Lütken, 1856

Ophiactis tricolor H. L. Clark

FIGS 33, 34

Ophiactis tricolor H. L. Clark, 1928: 427–428, Fig. 126; 1938: 262; 1946: 208.– A. M. Clark, 1966: 326 (in key).

Ophiactis laevis H. L. Clark, 1938: 268–270; 1946: 208.

Ophiactis luetkeni Koehler, 1907: 245.

Specimens examined: Holotype SAM K213, no locality data or depth; paratype SAM K214, no locality data or depth (Figs 33, 34); 2, NMNZ 2079, 3 km off West Beach, Gulf St Vincent, S.A., 9 m, 8.vi.1968; 2 NMNZ 2083, off Pt Marsden, S.A., 20 m, Jan. 1965; 1, NMNZ 2081, Yankalilla Bay, S.A., 18 m, no date; 1, NMNZ 2078, West Id, S.A., 2 m, 20.x.1967; 1, NMNZ 2082, wreck of *Norma*, Gulf St. Vincent, S.A., 12 m, 1.i.1965; 2, BPBM W1806, Investigator Strait, S.A., 30 m, no date; 2, BPBM W1809, Investigator Strait, 43 m, no date; 3, BPBM W1825 off Glenelg, Gulf St Vincent, S.A., 12 m, rock, among sponges, no date; 2, paratypes of *O. laevis* WAM 221/2–39, Bunbury, W.A., 26.x.1929, no depth; 2, WAM 499–74 SW of Bunbury, W.A., 20 m, 13.iv.1963; 4, NMNZ 2069, Eagle Bay, Cape Naturaliste, W.A., 1–5 m, 24.ii.1975; 1, NMNZ 1838, Yallingup, W.A., 1–3 m, 22.ii.1975; 1, MNB 4549, Geraldton, W.A., no depth; 1, ZMH E5444, Fremantle, Gage Roads, W.A., 7–18 m, 4.v.1905; 1, WAM 319–78, W side Goss Passage, Abrolhos Is, W.A., 33–35 m, no date.

Remarks: Ophiactis tricolor was described by H. L. Clark from Sir Joseph Verco's collections dredged in Gulf St Vincent and Spencer Gulf, South Australia. Clark (1938) mentioned a specimen of *tricolor* in the "Melbourne Museum" collected in 40 fathoms north of Cape Borda, Kangaroo Id, S.A. but there appear to be no subsequent records of this species in the literature. The new records listed

here show it to be distinctly southern and southwestern Australia in distribution.

H. L. Clark (1938) reported a second and new species, *O. laevis*, from dredged samples in Koombana Bay (Bunbury), and Dongarra, Western Australia, and provisionally attributed two specimens (MNB 4549 & ZMH E5444) from Fremantle and Geraldton (reported by Koehler 1907 as *O. leutkeni*) to his new species. Clark (1946, p. 207) separated *O. laevis* from *O. tricolor* by differences in the size of the disc scales, and radial shields, as well as by colour as follows:

O. laevis	*O. tricolor*
1. disc with smooth coat of small rounded scales.	disc scales larger and less smooth.
2. radial shields very small, not much larger than some of disc scales.	radial shields considerably larger.
3. disc usually purplish-rose arms variegated but not banded.	disc grayish or dirty yellowish, arms normally banded with pinkish white, rosy red, and dull blue.

Both species were characterized in Clark's key by: (a) a quite large single oral papilla, (b) radial shields small, less than .25 disc diameter, (c) very small and numerous disc scales.

The series of specimens available has shown that the small differences used by Clark to separate *laevis* from *tricolor* can be attributed to normal variation within the one species. Consequently, *O. laevis* is here synonymized with *O. tricolor*.

FAMILY Amphiuridae

Amphiura elandiformis A. M. Clark

Amphiura elandiformis A. M. Clark, 1966: 331, fig. 6 f–i.– Dartnall, 1980: 40, fig. 13.

Specimens examined: 3, NMNZ 1853, 43°00'S, 148°13.6'E, off Eaglehawk Neck, Tas., 122 m, 13.iii.1973; 1, NMNZ 2615, off Burnie, Tas., 20 m, 6.ii.1970; 1, NMNZ 2616, Great Taylor Bay, Bruny Id, Tas., 14.ii.1972.

Remarks: This species was previously known only from Pt Phillip, Victoria, and with its discovery in eastern Tasmanian waters, it may be expected along the entire southern Australian coast. The specimens range 5–7 mm d.d., and confirm the distinctive features of this amphiurid: the disc is petaloid and covered above with small scales, and below with naked skin. The radial shields are long (2.3 mm on the 7 mm specimen), narrow, and bowed. The distal oral papilla is wide and rounded, there are two tentacle scales on each pore, and the second to lowest arm spine has a proximally-directed hyaline hook or is bihamulate.

Amphiura elandiformis is similar to two other southern Australian amphiurids, *A. dolia* and *A. multiremula* (both of H. L. Clark) and one New Zealand species, *A. correcta* Koehler, but they can be distinguished by different combinations of the above features.

Amphiura multiremula H. L. Clark

Amphiura multiremula H. L. Clark, 1938: 228.– A. M. Clark, 1966: 336, fig. 7a–e.

Specimens examined: 1, NMNZ 2617, West Id, S.A., 2 m, 29.i.1975; 1, NMNZ 2618, Eagle Bay, W.A., 1 m, 24.ii.1975.

Remarks: This amphiurid was hitherto known only from 3 Port Jackson and Long Reef, N.S.W. specimens. The present specimens are 4.0 and 5.5 mm d.d., and the largest has 9 arm spines. This large number of arm spines, and their flat, blunt shape, help to characterize this species, which is otherwise distinguished from the many other Australian congeners by very fine, complete disc scaling, small radial shields (0.2–0.33 d.d.), and oral shields with a semicircular proximal border.

The holotype of *A. multiremula* has been figured by A. M. Clark (1966).

Amphiura magellanica Ljungman

Amphiura magellanica Ljungman, 1867: 320.– Mortensen, 1924: 132, fig. 14.

Specimens examined: 2, NMNZ 2620, S of Warrnambool, Vic., 220–310 m, 14.v.1969.

Remarks: This species is apparently circumpolar in subantarctic and cold temperate latitudes, having been recorded from the south Atlantic Ocean, Pantagonia, southern New Zealand and, now, southern Australia.

The two Warrnambool specimens measure 2.4 and 3.7 mm d.d. They show the characteristic lengthening of the lowermost of the 7 arm spines, and the large leaf-shaped distal oral papilla and tentacle scales. *Amphiura magellanica* is viviparous and hermaphroditic—features which separate the species from the similar *A. spinipes* Mortensen from New Zealand.

Amphiura trisacantha H. L. Clark

FIGS 43–48

Amphiura trisacantha H. L. Clark, 1928: 425, figs 125 a & b.

Specimens examined: Holotype, SAM K212, Spencer or St Vincent Gulfs, S.A., no depth or date; 1, NMNZ 2073, Upper Spencer Gulf, S.A., 9 m, 11.ix.1973; 1, NMNZ 2619, North Arm, Westernport, Vic., 4 m, 13.vi.1976.

Remarks: This species was hitherto known only from the holotype. The new material measures 2.5 and 6.5 mm d.d., and although all the arms are broken, fragments with the largest specimen indicate arms 4–5 × d.d. The arm spines number 5 at the arm bases, and reduce to 3 within six segments. The uppermost spines are pointed and slightly flattened, and the longer lowermost spines are more circular in cross section, and evenly tapered to a sharp point.

In other respects the specimens are in close agreement with the holotype and Clark's description. Clark's photograph of the holotype does not illustrate the species adequately, and we therefore provide camera lucida drawings of the now damaged type specimen (Figs 45–48) and the one from Upper Spencer Gulf (Figs 43 & 44).

FAMILY Ophiotrichidae

Ophiothrix Müller & Troschel, 1840

Ophiothrix (Placophiothrix) albostriata H. L. Clark

FIGS 49–54

Ophiothrix albostriata H. L. Clark, 1928: 429, fig. 127.

Placophiothrix albostriata H. L. Clark, 1946: 227.

Ophiothrix (Placophiothrix) albostriata A. M. Clark, 1967: 648.

Specimen examined: Holotype SAM K215, Great Great Australian Bight, no depth or date.

Remarks: This holotype (d.d. 10 mm) remains the only known specimen and we give here drawings of various parts of it to supplement Clark's description and figure. The specimen is now very faded, but two parallel lines are visible on both dorsal and ventral surfaces of the arms after about the 20th segment. This species is similar to *O. (Placophiothrix) spongicola* in general appearance, but differs in the shape of its dorsal arm plates and oral shields. The disc cover and overall colour pattern were stressed by H. L. Clark as being definitive, but in our experience, the variation in these features shown by *O. (Placophiothrix) spongicola* encompasses those in *albostriata*. The disc cover of *O. albostriata* is also like that of *O. (Placophiothrix) lineocaerulea* H. L. Clark (holotype SAM K218) (Figs 55–59). The dorsal and ventral arm plates (Figs 52–54, 57 & 58) are, however, quite distinct in these two species, and *O. lineocaerulea* is known only from northern and eastern Australia, from Broome to Moreton Bay.

Ophiothrix (Keystonea) hymenacantha H. L. Clark

FIGS 60–62

Ophiothrix hymenacantha H. L. Clark, 1928: 431, fig. 128.

Ophiotrichoides hymenacantha: H. L. Clark, 1946: 233.

Ophiothrix (Keystonea) hymenacantha A. M. Clark, 1967: 648.

Specimen examined: Holotype, SAM K217, Great Australian Bight, no depth or date.

Remarks: This species is known only from the 8 mm holotype. H. L. Clark (1946) inferred that the specimen might be from the north-western coast of Australia, rather than the Bight, but there is no information on the label to suggest this, and in the absence of new material we must assume it is a southern form. There are of course other "northern" ophiuroids in the Great Australian Bight and South Australian gulfs (e.g. *Astroboa ernae* Döderlein & *Amphioplus ochroleuca* (Brock)), and it may well be that if this is a representative of the tropical subgenus *Keystonea*, it has evolved in the relative isolation of the southern region.

In many ways, however, *hymenacantha* reminds us of an aberrant *O. (Placophiothrix) spongicola*—it has the same shaped arm spines, arm plates, and oral shields, and we have seen *spongicola* specimens with a naked dorsal disc surface. We have as well encountered webbed arm spines in small specimens of the several hundred *spongicola* examined: Up to a d.d. of 3 mm, specimens of *O. spongicola* from the Abrolhos Is, W.A., and Investigator Strait, S.A., reveal, on segments under the disc, proximal arm spine webbing, as well as upper arm plates with scattered low thorny stumps. Larger specimens, however, lack these apparent juvenile characters. In view of that last fact, and the very distinctive colour pattern of *O. spongicola* (see Baker 1981), we consider that the colourless, enigmatic *O. hymenacantha* should be retained in the subgenus *Keystonea* by virtue of its naked upper disc surface, at least until a growth series is found which indicates another relationship. Figures 60–62 show diagnostic features of the type specimen.

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